



# Research Reactor Center

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Director of Nuclear Reactor Regulation  
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U. S. Nuclear Regulatory Commission  
Washington, DC 20555

REFERENCE: Docket No. 50-186  
University of Missouri Research Reactor  
License R-103

SUBJECT: Report as required by T.S. 6.1.h.(2) regarding reactor operation with the  
regulating blade inoperative.

### Description:

At 0850 on April 7, 2000, with the reactor operating at full power in the automatic mode, a CHANNEL 4, 5 OR 6 (power ranges) 95% DOWNSCALE annunciator was received. The annunciation locked in. Investigation revealed the regulating blade drive was inoperative. The reactor was shutdown by manual scram at 0856 to be in accordance with Technical Specification (T.S.) 3.2.a., which states, "all control blades, including the regulating blade, shall be operable during reactor operation." With the regulating blade drive inoperative, the rod run-ins associated with the regulating blade (<10% withdrawn and rod bottomed), listed under T.S.3.4.c, were inoperative.

Preceding the failure, the reactor had been in continuous full power operation with the regulating blade properly maintaining power in automatic control for a period of 81 hours 1 minute since the scheduled maintenance day on April 3, 2000. A review of operations logs and the wide range and power range chart indications verified the operability prior to the failure. The reactor operator manually attempted to shim the regulating blade while another operator monitored the regulating blade drive verified the regulating blade drive inoperative.

### Analysis:

The regulating blade system is used to automatically control reactor power level (normally 10 MW). The blade is constructed of stainless steel and is driven at 40 inches per minute by the regulating drive mechanism. The regulating drive mechanism consists of a drive servomotor, gearbox assembly, and a ball/lead screw arrangement to translate the rotary motion of the motor and gearbox to the linear motion of the regulating blade.

In the automatic mode, the regulating blade controls reactor power by comparing the output of the Wide Range Monitor (WRM) with the setting provided by the power schedule potentiometer set by the reactor operator. Any difference between the WRM indication and the potentiometer setting creates a drive signal to the regulating blade drive mechanism. The blade frequently shims to make minor adjustments to maintain power at the desired level in automatic control.

When the annunciator alarm was received, immediate inspection of all three power range and WRM charts indicated an actual power decrease starting two minutes before the annunciation. The regulating blade was still in automatic control at this time, but the blade was not moving out in response to the difference between the WRM indication and the potentiometer setting. The duty operator then switched the regulating blade control to manual while other operators were inspecting the drive. The regulating blade drive motor

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was responding but the drive itself did not appear to be operating. The reactor was shutdown by manual scram at 0856 to repair the regulating blade drive mechanism.

There is a preventive maintenance (PM) procedure for the regulating blade that requires the gearbox to be changed out every two years and rebuilt. The problem was caused by the gearbox failing that was installed on February 7, 2000, when this PM was performed. After the failure, the regulating blade drive was removed and the drive repaired by replacing the gearbox. An investigation of the gearbox determined that the setscrew for the main drive gear had come loose allowing the gear to slip on the shaft. This prevented the gearbox output shaft from turning. The setscrew should have been held in place with Loctite, but no Loctite had been applied to this setscrew.

The drive was reinstalled and tested over its full range of travel. The regulating blade portion of CP-14 (Regulating Blade 10% and Rod Bottom RRI Rod Not in Contact with Magnet RRI) was completed satisfactorily.

The review of the wide range and power range charts indicated that the reactor had operated for a maximum of eight minutes with the regulating blade mechanism inoperable. Reactor operation during this time deviates from Technical Specification 3.2.a., which states, "all control blades, including the regulating blade, shall be operable during reactor operation."

With the regulating blade mechanism inoperable, the rod run-ins associated with the regulating blade (REG ROD <10% or BOTTOMED) would also have been inoperable. This deviates from Technical Specification 3.4.c. which states, "The reactor shall not be operated unless the following rod run-in functions are operable...Regulating Blade Position <10% withdrawn and bottomed."

The regulating blade and its associated rod run-in features are not part of the reactor safety system as defined in Technical Specification 1.18. When a reactor scram or rod run-in occurs, the regulating blade is automatically shifted to manual control to stop it from moving to maintain power by shimming. The basis for the rod run-ins associated with the regulating blade is to assure termination of a transient, which in automatic operation is causing a rapid insertion of the regulating blade.

**Corrective Action:**

The reactor was shutdown by manual scram when it was determined that the regulating blade drive mechanism was not operable. The gearbox was replaced; the regulating blade drive was tested and returned to operation. The operability of the regulating blade and associated rod run-ins and indication was verified. A step has been added to the preventive maintenance procedure for replacing and rebuilding the gearbox to check that Loctite has been put on the setscrew for the main drive gear.

Sincerely,



J. Charles McKibben  
Interim Reactor Manager

Xc: Mr. Alexander Adams, Jr, NRC  
Mr. Craig Bassett, NRC

  
CHRISTINE M. ERRANTE  
Notary Public - State of Missouri  
County of Boone  
My Commission Expires 04/14/2003